

If the effect endpoints are similar, it is then typical to add the results. However, to provide a "worst" case assessment for a given region, one may just add all the values (although this may not be the worst case if the synergistic effects are considerable.) This summation is subjective and a value greater than one still does not indicate an actual impact. The value provides a relative indicator based on the sum of all the potential contributions associated with different effect endpoints. This is common practice in other impact/risk assessment arenas and no distinction is made between effects. A notable exception is between carcinogens and non-carcinogens, although there are indications that this practice may change.

Similarly, although more detail is gained by considering potential contributions on a regional scale, the decision maker will probably sum the values for the different regions to facilitate a comparison of the different life cycles. Again, this may not indicate actual effects, but it will provide an indication of the overall contributions of one life cycle to facilitate a comparison with another in the category of toxicological impacts. Furthermore, the lack of distinction between areas will avoid discrimination against processes in less pristine regions of the world, a feature that may have both good and bad connotations.

The alternative to simple aggregation may be to consider background concentrations of all the chemicals in each region with a similar effect endpoint, as well as the temporal data for each emission, etc. Unfortunately, this data is not typically available, even for most "detailed" risk assessments. Thus, the decision will typically have to be made on the basis of aggregated data across different effect endpoints and regions unless the application of LCA is to be restricted. As this is the current "state-of-the-art" in many risk/impact assessment domains, not just in LCA, it is hard to see why this practice should be limited on this basis. However, there is obviously room for improvement in the LCA approach and the methodologies used to develop potentials. These advancements may include the inclusion of temporal information to enable the consideration of contributions occurring over different time spans.

References

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Reply

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The article referred to by DAVID W. PENNINGTON was a commentary, summarizing the continued evolution of Life Cycle Impact Assessment (LCIA) in one particular area, the use of subjectivity. The commentary pointed to the efforts of SETAC (BARNTHOUSE et al., 1997; UDO DE HAES et al., 1996), ISO (ISO, 1998), and ILSI (ILSI, 1996) to examine and reappraise the use of subjectivity in LCIA. In ISO terminology, subjectivity is referred to as value-choices.

To summarize the trust of the original commentary, the issue is not one of simplifying assumptions that are consistent with basic environmental science. All techniques simplify their models and processes by making assumptions, and all techniques must make these assumptions transparent. The issue for LCIA is the use of subjectivity or scoring schemes. This is especially important to recognize where these scoring schemes are applied and may masquerade as science or fact in LCIA methods.

This important reappraisal by members of the above organizations has consistently supported a key position from the original SETAC Sandestin workshop. A common mode of action or homogeneous mechanism is a necessary and essential element for scientific validity (SETAC, 1993). All of the above organizations, as well as many individuals, have recognized that this common mode of action or homogeneous environmental mechanism does not exist for a number of LCIA impact categories. Instead, scoring schemes are created for a number of impact categories through subjective judgement. These scoring schemes are involved in several ways as noted by the article. Scoring based on subjectivity is the basis for

1. certain impact categories such as resources, ecotoxicity, and human toxicity where independent mechanisms and substances are combined,

2. some characterization factors, and
3. the aggregation of converted inventory results into a category indicator result where substances act independently and, thus, are not additive in the actual environment.

This position has now been recently echoed in a summary report on the work by two SETAC work groups on LCIA (SETAC, 1998; this summary is available on the SETAC Website www.setac.org in the LCA section.

As noted by BARNTHOUSE et al. (1998): Executive Summary, section IV; "Subjective judgements are an inevitable consequence of efforts to aggregate various inventory parameters into category indicators. Subjective judgements are themselves valuation systems, i.e. the combination of independent parameters like different resources or the combination of different toxicological endpoints. Many subjective judgements in LCIA are not justified scientifically" and in Table 3-3 on pages 74 and 75 of BARNTHOUSE et al.; these Life Cycle Impact Assessment experts in the SETAC work group note that limited or absent plausibility for several current approaches to impact categories and models for indicators. Again, as a commentary review, I have highlighted these findings and points for the LCA community to recognize and discuss.

A very important point of discussion is that I believe the credibility of LCA may be at stake in some quarters. Given constant referrals to "transparency" in LCA, these subjective judgements need to be clear to all parties, but often they are not. This contradictory situation has fostered doubts about the credibility and usefulness of LCA in some quarters. Almost all practitioners and users have heard in one form or another the disparaging remark about LCA as an environmental tool: "You can get any answer you want with LCA."

To be and remain credible, LCA must in future

1. more clearly define when science and subjected scores are used,
2. acknowledge subjective scores as such and make their use transparent, and
3. improve communication about the value and the limitations of the indicator results generated during a study.

SETAC, ISO, and ILSI have all outlined steps to improve the practice of LCA in this area:

- ♦ All subjective judgements should be reviewed in the study goal and scope definition for acceptance by parties initiating the study and the intended study audiences.
- ♦ Subjective judgements should be transparently documented, including 1) any compromise of science know-

ledge, 2) effect on the individual category result, and 3) effects on the overall study result.

- ♦ The environmental relevance of indicators should be evaluated using other environmental data and assessment techniques.
- ♦ Subjective judgements and environmental relevance need to be specifically scrutinized by the peer or critical review process.

LCA needs clear solutions and transparency on these subjective scoring schemes to maintain the trust of users, decision-makers, and the audiences for both LCA itself and decisions made using LCA. I would counsel that apologies and lack of transparency for subjective scoring schemes will not gain this trust for LCA as an useful and important environmental tool. I take the position that the actions recommended by the above organizations are both wise and necessary.

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